

582 - OPEN CHANNEL

Definition

Construction or improving a channel, either natural or artificial, in which water flows with a free surface.

Scope

This standard covers the construction of open channels or modification of existing streams or ditches. Design criteria for channel stability and maintenance of Floodwater Diversion (400), Floodway (404), or Surface Drainage, Main or Lateral (608) having a drainage area in excess of 1 square mile (1.6 km) shall be in accord with this standard for open channels. It does not apply to FOTG Standard 362 - Diversion, 412 - Grassed Waterway or Outlet, 326 - Irrigation Canal or Lateral, 388 - Irrigation Field Ditch, or 607 - Surface Drainage, Field Ditches.

Purpose

To provide discharge capacity required for flood prevention, drainage, other authorized water management purposes, or any combination of these purposes.

Conditions Where Practice Applies

This standard applies to all earth channel construction or modification except as noted under "Scope".

It also applies where stability requirements can be met, where the impact of the proposed construction on water quality, fish and wildlife habitat, forest resources, and quality of the landscape is evaluated and the techniques and measures necessary to overcome the undesirable effects are made part of any planned work, where an adequate outlet for the modified channel reach is available for discharge by gravity flow or pumping, and where excavation or other channel work does not cause significant erosion, flooding, or sedimentation.

Planning Considerations for Water Quantity and Quality

Concentrating flow in an open channel may reduce the opportunity for infiltration, and increasing runoff. The amount of increase will depend on the extent that surface flows were spread before collection in the channel and the permeability of the soils in the floodplain. Open channels may result in a negligible to major decrease in ground water recharge quantity.

Open channels will have minor long-term impact on surface water quality. There may be an initial increase in erosion and sediment yield from the channel and surrounding

areas during and immediately after construction. These should be minimal after the first period of use and establishment of vegetation. There may also be a minor increase in the transport of soluble pesticides from adjacent areas due to type and amount of pesticide used, soil characteristics, and precipitation patterns at the time of pesticide use.

An increase in temperature may increase water surface areas subject to solar radiation, especially if associated with decreased vegetative canopy.

Minor changes in ground water quality will result from the infiltration of small amounts of soluble pesticides used to control vegetation in and along open channel banks. Plans for open, channel should, where possible, eliminate surface and ground water pollution.

Design Criteria

Plan

Channel construction or modification is to be in accordance with an approved plan developed for the site. Technical Release No. 25 shall be used in the surveys, planning, and site investigations for channel work. Those portions of TR 25 relating to design criteria shall be followed, using the procedure best adapted to site conditions.

In selecting the location and design of channels, careful consideration shall be given to minimizing water pollution, damage to fish and wildlife habitat, and to protect forest resources and the quality of the landscape. In considering requirements for construction and operation and maintenance, selected woody plants must be preserved. The overall landscape character, prominent views, and fish and wildlife habitat requirements must be considered.

Planned measures necessary to mitigate unavoidable losses to fish or wildlife habitat shall be included in the project. The quality of the landscape shall be maintained by both location of channel works and plantings as appropriate.

The alignment of channels undergoing modification shall not be changed to the extent that the stability of the channel or laterals thereto is endangered.

Channel Capacity. The capacity for open channels shall be determined by procedures applicable to the purposes to be served, and in accord with related FOTG Engineering Standards and Handbooks. The water surface profile or hydraulic grade line for design flow shall be determined in accord with guidelines for hydraulic design in TR 25. The "n" value for aged channels shall be based on the expected vegetation along with other retardance factors considering the level of maintenance in the operation and maintenance plan developed with the owners or sponsors. The required capacity may be established by consideration of volume-duration removal rates, peak flow, or a combination of the two as determined by the topography, purpose of the channel, desired level of protection, and economic feasibility.

Channel Cross Section. The required channel cross section and grade are determined by the plan objectives, the design capacity, the materials in which the channel is to be constructed, the vegetative establishment program and the requirements for operation and maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, laterals, or streams. Urban and other high value developments through which the channel is to be constructed must be considered in design of the channel section.

Channel Stability. Characteristics of a stable channel are:

1. The channel neither aggrades nor degrades beyond tolerable limits.
2. The channel banks do not erode to the extent that the channel cross section is changed appreciably.
3. Excessive sediment bars do not develop.
4. Gullies do not form or enlarge because of the entry of uncontrolled surface flow to the channel.

All channel construction and modification (including clearing and snagging) shall be in accord with a design which can be expected to result in a stable channel which can be maintained at a reasonable cost. Vegetation, riprap, revetments, linings, structures or other measures are to be used where necessary to insure stability.

The method applicable to site conditions in TR 25 shall be used in determining the stability of proposed channel improvements.

Bankfill flow is defined as the flow in the channel which creates a water surface that is at or near the normal ground elevation, or the tops of dikes or continuous spoil banks that confine the flow for a significant length of a channel reach.

Channels must be stable under conditions existing immediately after construction (as-built condition) and under conditions existing during effective design life (aged condition). Channel stability shall be determined for discharges under these conditions as follows:

1. As-built condition - Bankfill flow, design discharge, or 10-year frequency flow, whichever is smallest, but not less than 50% of design discharge.
The allowable as-built velocity (regardless of type of stability analysis) in the newly constructed channel maybe increased by a maximum of 20% if:
 - (a) The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation,
 - (b) Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known, and

- (c) The channel design includes detailed plans for establishing vegetation on the channel side slopes.
- 2. Aged condition - Bankfill or design discharge, whichever is larger, except that it is not necessary to check stability for discharges greater than the 100-year frequency.

Stability checks that are flow related are not required if the velocity is 2 ft/s (0.6 m/s) or less.

For newly constructed channels in fine-grained soils and sands, the "n" values shall be determined in accordance with Chapter 6 of TR 25, and shall not exceed 0.025. The "n" value for channels to be modified by clearing and snagging only shall be determined by reaches according to the expected channel condition upon completion of the work.

Appurtenant Structures. The channel design will include all structures required for the proper functioning of the channel and its laterals as well as travelways for operation and maintenance. Inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the channel design. The design also is to provide for necessary flood gates, water level control devices, bays used in connection with pumping plants and any other appurtenances essential to the functioning of channels and contributing to the attainment of the purposes for which they are built. When needed, protective structures or treatment shall be used at junctions between channels to assure stability at these critical locations.

The effect of channel work on existing culverts, bridges, buried cables, pipelines, irrigation flumes, and inlet structures for surface and subsurface drainage on the channel and laterals thereto shall be evaluated to determine the need for modification or replacement.

Culverts and bridges which are modified or added as part of channel projects shall meet reasonable standards for the type of structure, and shall have a minimum capacity equal to the design discharge or state agency design requirements, whichever is greater. In many cases, it will be desirable to increase the capacity of culverts and bridges above the design discharge.

Disposition of Spoil. Spoil material resulting from clearing, grubbing and channel excavation is to be disposed of in a manner which will:

- 1. Not confine or direct flows so as to cause instability when the discharge is greater than bankfull flow.
- 2. Provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed.
- 3. Not hinder the development of travelways for maintenance.

4. Leave the right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses.
5. Direct water accumulating on or behind spoil areas to protected outlets.
6. Maintain or improve on the visual quality of the site to the extent feasible.

Vegetation of Channel. Vegetation will be established on all channel slopes, berms, spoil and other disturbed areas except where the slopes are permanently covered with water or where bank material, land use, and climatic conditions are such that vegetation is impractical. Vegetation will be established in accordance with Channel Vegetation (322).

Operation and Maintenance

Plan. An operation and maintenance plan must be developed for each channel system. Minimum requirements for operation, maintenance and replacement are to be established consistent with the design objectives. This includes consideration of fish and wildlife habit, quality of the landscape, water quality, mitigation features, methods, equipment, costs, stability, function for design life, frequency, and time of year for accomplishing the work. Detailed provisions for operation and maintenance must be made where complex features such as water level control structures and pumping plants are involved.

Maintenance Access. Travelways for maintenance will normally be provided as a part of all channel work. This requirement may be met by providing ready access points to sections of channel where this will permit adequate maintenance in conformance with the Operation and Maintenance Plan.

A travelway shall be provided on each side of large channels if necessary for use of maintenance equipment. Travelways must be adequate for movement and operation of equipment required for maintenance of the channel. The travelway may be located adjacent to the channel on a berm or on the spread spoil. In some situations the channel itself may be used as the travelway. The travelway, including access points, should blend into the topography and landscape, and adjacent land uses.

Safety. Open channels can create a safety hazard. Appropriate safety features and devices should be installed to protect people and animals from accidents such falling or drowning.

Plans and Specifications

Plans and specifications for construction of Open Channels shall be in keeping with this standard and shall describe the requirements for proper installation of the practice to achieve its intended purpose.

References: National Engineering Field Manual for Conservation Practices.

Alabama Conservation Drainage Guide.
Technical Release No. 25.
Guide for Selecting Roughness Coefficients.